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NOAA Award No. NA96GP0240: California Fishery, Farm and Environmentally-Vulnerable Community Responses to the 1997-98 ENSO Event

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I. Preliminary materials

A. Abstract

We conducted a two-year integrated, retrospective social science study, based on archival materials and ethnographic approaches, that examined: (1) the biogeophysical conditions in the Monterey Bay Region (MBR) of California before and after the 1997-98 ENSO; (2) the ENSO's regional impacts and effects; (3) early warnings of the ENSO, including their source, content, presentation and reception; and (4) decision-making by members of three especially vulnerable socio-economic sectors within the MBR—fishers, farmers, and selected mountain and river valley residents—and its effectiveness in enabling individuals to successfully adjust and adapt to the ENSO. We found that: (1) there is a distinct contrast between risk and vulnerability, as calculated and acted upon; (2) there is a repertoire of responses to hazards, based substantially on “local knowledge,” that is often sui generis to a specific community; (3) there is an epistemological disjuncture between emergency service agencies and vulnerable communities; and (4) personal and social knowledge is often more important than formal information in determining responses to climatic variability and extreme hazards.

B. Objective of research project

The 1997-98 ENSO caused significant disruptions throughout California, especially for coastal farmers, fishers and residents, whose social and economic systems are highly dependent on natural resources and landscapes and, therefore, vulnerable to climate fluctuations. Through this project, we explored how these social and economic systems were affected by the 1997-98 ENSO, how technical and other types of information about expected variability in the climate system prompted changes in human behavior, and whether these changes resulted in successful (or unsuccessful) adjustment and adaptation to this most recent ENSO episode. In particular, we sought to understand:

- how individuals made decisions in the face of information about potentially severe climatic conditions and variability,
- which sources of information were most important and effective in preparing and responding to extreme events,
- the extent to which their prior experience with earlier ENSO events (1982-83, 1992-93) affected their decision-making, and
- the role individuals' social networks played in the dissemination of useful knowledge to facilitate (or obstruct) adaptation and adjustment to ENSO conditions.

C. Approach

We sought to address a fundamental question: How do individuals decide how to act in the face of uncertainty, given structural and other constraints? It is often assumed that individuals are (boundedly) rational actors. They seek information about hazards and risks as well as alternative responses, estimate and weigh the costs and benefits of these alternatives, and choose the most “rational” course of action. Such an approach treats risk as objectively quantifiable, risk perception as exogenously-given and simply a matter of “knowing the facts,” and contradictory responses to risk as a form of “irrational pathology.” Yet this approach neglects the broader social context within which these actions take place, thus limiting the predictive accuracy and utility of the “rational actor” approach.

We used an ethnographic approach to assess subjects’ vulnerabilities and responses, complemented by archival research to investigate coastal farmers', fishers' and residents' perceptions, knowledge, experience and actions associated with the 1997-98 ENSO in social, economic and environmental contexts. We used this integrated approach to examine

- the biogeophysical conditions in the Monterey Bay Region (MBR) of California before and after the 1997-98 ENSO event;
- the event's regional impacts and effects;
- early ENSO warnings, including their source, content, presentation and reception;
- decision-making by members of three especially vulnerable socio-economic sectors within the MBR (fishers, farmers, and selected mountain and river valley residents);
- and the effectiveness of prior information in enabling individuals to successfully adjust and adapt to the ENSO and resulting conditions.

We then integrated the resulting data to test the following hypotheses:

- Advance interseasonal warning of an impending ENSO provides critical inputs for individuals' and agencies' hazard and risk planning.
- Individuals' vulnerability is often more directly affected by factors such as limited or variable income, demographics, and markets (demand and prices for products) than by weather and climate conditions.
- Those most vulnerable to variable climate and weather rely more heavily on personal knowledge and experience and local social networks than on external information or other resources to mitigate their vulnerability and respond to climate variability and extreme events.

D. Matching funds used for this research

Formally, no matching funds were used for this project, although two sets of resources provided critical support and played an essential role in the research. First, prior to and coincident with this project, co-PI Pomeroy was engaged in three research projects with Monterey Bay area commercial fishers. Second, for the present project, as well as for the studies just described,

farmers, fishers, community residents, and agency and NGO personnel contributed many hours of their uncompensated time, their knowledge, experience and expertise, and valuable contacts and assistance with entree.

The studies conducted by Pomeroy included a California Sea Grant-sponsored study of the social and economic organization of the California squid fishery (with M. FitzSimmons), a NOAA-sponsored study of the potential socio-economic impacts of proposed marine reserves on Channel Islands squid fishers, and an NMFS-sponsored study of the socio-economic impacts of pinniped-fishery interactions on central California commercial salmon trollers. The studies of the squid fishery occurred prior to, during and immediately following the 1997-98 ENSO, which had a particularly severe impact on Monterey Bay area (and other) squid fishermen and associated processors, harbors and various associated service providers. The salmon fishery study, conducted in late 1999 and 2000, focused on trollers' experiences from 1997 through 1999, and included the 1997-98 ENSO. The approaches used in all three studies, which included ethnographic, survey and archival research, enabled us to address this project's objectives within the context of these ongoing studies.

II. Interactions with decisionmakers and agency staff

A. Local decisionmakers and agency staff

As part of the data collection for the project, we interviewed local decisionmakers and staff in relevant county and more local agencies, including those addressing resource conservation, regional hydrology, agriculture, emergency services, social services, and municipal administration.

B. Interactions with climate forecasting community

None

C. Interactions or coordination with other HDGCR projects

None

III. Accomplishments

A. Methods and tasks

We combined ethnography (in-depth interviews and observation) with archival research to address this study's goals and objectives. The study consisted of two stages. The first was an exploratory one, and entailed the collection and analysis of archival data, informational interviews, and the development and pilot testing of a survey interview to be used for data collection during the second stage of the study. Specific tasks are described below.

Task 1: Collection of data on ENSO-related weather and climate parameters to develop a “hazard scale” to pinpoint research sites around the MBR.

We identified numerous sources of MBR weather and climate data, and began creating a hazard scale to develop an “objective” sense of conditions, and to pinpoint research sites within both the larger MBR and the three groups of research interest. We found information in numerous databases available on the web, including NOAA and other regional sites. Data of interest included air and sea surface temperature, precipitation, wind speed and direction and other weather- and climate-related measures. In addition, we obtained more focused qualitative and quantitative data that provided insights into critical intra-regional climate differences. As noted below, however, this information proved to be of limited utility in locating specific groups of fishers, farmers and residents on which to focus our interview efforts. Rather, we found local media and key informant accounts of weather- and climate-related events more useful in finding people in particular places who were confronted by the vagaries of uncertain, variable and at times severe weather.

Task 2: Collection of forecasts for 1997-98 issued by public media and agency sources, as well as reports on consequences of storms, to determine how the information therein was mediated and transformed by the communication process.

We conducted an extensive search for and review of local media- and agency-reported information related to the 1997-98 ENSO and other events identified by interviewees (e.g., the 1982-83 ENSO, the 1995 Pajaro River floods). Newspaper archives—most notably the *San Jose Mercury News* and the *Santa Cruz County Sentinel*—proved to be an especially rich source. Initially, we used keyword searches to identify potentially appropriate articles on the three sectors of interest; later, we examined daily newspapers for reports, which proved much more informative. We conducted a systematic content analysis of these articles to assess individual and group experiences with weather and climate, the larger social, economic and regulatory context of these experiences, and the potential and actual vulnerabilities of individuals and communities revealed by these experiences. From this analysis, we constructed a timeline of weather-related events, experiences and outcomes for each of the three groups within the region.

Task 3: Identification of specific sites, relevant agencies and staff, and affected individuals, groups and communities to interview in order to understand vulnerabilities, knowledge and experience related to the 1997-98 ENSO, and other weather and climate events .

Using information acquired through task 2, together with a series of informational and exploratory interviews, we identified potential communities and groups to approach for interviews. In our investigation of resident communities, we soon became aware of two sets of communities in the Santa Cruz Mountains (SCM) and the Pajaro River Valley (PRV) that would be of interest in themselves, in comparison to their local counterpart, and between the two areas (SCM and PRV). For our work with farmers (locally referred to as “growers”), we relied more on a generalized snowballing approach, through which we sought contact with organic and conventional growers. In seeking to address both squid and salmon fisheries, we drew heavily on Pomeroy’s ongoing research as noted elsewhere in this report.

Task 4: Pilot interviews with agency personnel and affected individuals.

In addition to our exploratory/informational interviews, we designed, tested and conducted a set of pilot interviews with a small set (15) of residents and growers. These pilot interviews were highly structured, and included detailed questions about individuals' background, knowledge about weather and climate, sources of information in general and for weather and climate in particular, experience of severe events, and information needs.

Task 5: Analysis of stage 1 data and modification of research strategy for stage 2.

We analyzed our stage 1 archival and field data both to inform our understanding of how MBR residents, growers and fishers perceived and responded to the 1997-98 ENSO in their larger social context, and to evaluate and modify our research strategy for stage 2 interviews. The results of our data analysis are incorporated in our overall findings below. Our evaluation of the pilot research strategy, however, warrants mention here.

Through our pilot interviews, we became acutely aware of the limitations of conducting a highly structured survey. For both interviewees and interviewers, such an approach was considerably less comfortable and productive than we had expected. The pilot interviewees provided us with very helpful feedback on the structure and content of the survey and our approach. Many noted feeling constrained to provide a particular type of response or follow a specified line of thought. Asking respondents about many consecutive weather events proved tedious. Moreover, whereas some respondents thought through their experiences linearly, others tended to think about them in terms of types of weather or impacts, and in some cases recalled more distant events only after discussing more recent ones at length. These factors led us to refine our approach and adopt an ethnographic interview style for our second, larger set of interviews.

Task 6: Semi-structured interviews with a broad range of agency personnel and affected individuals.

The second stage of the project built upon the first, and included supplemental archival research and expanded fieldwork based on ethnographic interviews with a broad range of agency personnel and affected individuals. We used the results of our pilot interviews to derive a set of key themes to explore in our subsequent, semi-structured interviews. We conducted most interviews as a team, with one person taking the lead and using an interview guide that listed these themes. The second person took primary responsibility for note taking and tape recording (when permitted by the interviewee), and used a more detailed checklist to insure that all themes and associated details were addressed in the interview.

B. Key research results

1. Hypotheses

- Advance interseasonal warning of an impending ENSO provides critical inputs for individuals' and agencies' hazard and risk planning.

- Individuals' vulnerability is often more affected by factors such as limited or variable income, demographics, and markets (demand and prices for products) than weather and climate considerations.
- Those vulnerable to variable climate and weather rely more heavily on personal knowledge and experience and local social networks than on external resources to mitigate their vulnerability and respond to climate variability and extreme events.

2. Data Collected

- Archival materials, including newspaper articles, agency publications, climate and weather data
- Pilot survey data from residents and growers
- Ethnographic interviews with residents of two vulnerable areas, lettuce and strawberry growers, and squid and salmon fishers
- Focused interviews with relevant decisionmakers and agency staff

3. Key Findings

H1. Advance interseasonal warning of an impending ENSO provides critical inputs for individuals' and agencies' hazard and risk planning.

- KF1. Advance interseasonal warning of an impending ENSO provides critical inputs for agencies' hazard and risk planning, although its utility to residents, growers and fishermen is more complicated and variable.
 1. Such warnings provide a "signal" to residents, growers and fishers to draw upon their locally contextualized experience and cumulative knowledge, which then guide their action.
 2. The variability of local microclimates in the region, together with uncertainties about how such events will manifest locally, limit the extent to which these groups prepare for associated contingencies.
- KF2. Because of their investments in growing and fishing, the demands of local and global markets, and the potential loss of these markets if one fails to deliver, growers and fishermen pursue their conventional "annual round" of activities notwithstanding ENSO information, and adapt on shorter time scales (i.e., as events and conditions unfold).

H2. Individuals' vulnerability is often more affected by factors such as limited or variable income, demographics, and markets (demand and prices for products) than weather and climate considerations.

- KF3. For many residents, limited or variable income in an area where real estate prices and the cost of living have increased dramatically in recent years constrains their ability to make substantial (weather-resisting) improvements to their homes or to relocate elsewhere.

1. For residents of the Santa Cruz Mountains and the Pajaro River Valley, other amenities, most notably the climate, and other social and economic aspects of the living conditions (apart from occasional severe weather and climate events) foster a strong attachment to their respective locations.
2. These more general conditions compensate for, or obscure, weather- and climate-related vulnerabilities, especially relative to other kinds of vulnerabilities and chronic social and economic concerns.
3. For growers and fishermen, variable and uncertain weather are inherent to their activities, and thus not perceived as a direct source of their vulnerability. Rather, their vulnerability follows from economic and regulatory variability and uncertainty, which may dictate action counter to what their knowledge, experience and responses to biophysical conditions might otherwise warrant.

H3. Those vulnerable to variable climate and weather rely more heavily on personal knowledge and experience and local social networks than on external resources to mitigate their vulnerability and respond to climate variability and extreme events.

- KF4. The diversity of topography, biophysical, social and economic conditions, microclimates and the interactions among these dimensions within the MBR are not readily captured, much less explicitly addressed, by externally generated information and other resources.
 1. Recognizing the limitations of externally generated information and other resources in addressing their particular vulnerabilities, residents, growers and fishers have developed individual and collective strategies whereby they draw on their own and others' experience and knowledge to mitigate their vulnerability and inform their responses. In many instances, these strategies have proved to be particularly robust.

C. Elaboration of key findings

1. Groups interviewed

In investigating Monterey Bay area growers', fishers' and community residents' perceptions of and responses to the 1997-98 El Niño, we focused our attention on particular groups within each of these categories.

- Among growers, we focused on those who raise strawberries and lettuce, two crops that are especially sensitive to weather and climate conditions, each in its own way. The growers we worked with included both conventional and organic growers, and varied considerably in the acreage, location and ownership of the land they worked, years of experience and degree of specialization.

- Among fishers, we worked with purse seiners who target squid (along with other wetfish species such as sardine and anchovy) and trollers who target salmon (and in many cases albacore tuna and other coastal species) as an important part of their annual round of fishing.
- Among residents of environmentally vulnerable communities, we identified and worked with two communities in the Santa Cruz Mountains, and two communities in the Pajaro River Valley.

Focusing on these subgroups among the larger groups growers, fishers, and residents afforded a broader understanding of the variability among the groups, and enabled us to make comparisons of responses within those groups (e.g., of lettuce and strawberry growers).

2. Risk vs. vulnerability

One of our more important focuses addressed the differences between risk and vulnerability, and the ways in which individuals decide what to do in the face of uncertainty and structural constraints, especially where climatic variability and extreme weather events are concerned. We began with the standard answer to this question: they attempt to acquire information about alternatives, estimate the costs and benefits of different possibilities, choose a particular course of action, assess the outcome as a success or failure, and learn for the future. While this schema does highlight the general approach of rational individuals to decisionmaking and action, we found that it largely excludes the broader social context within which responses take place.

We assumed that the ability to forecast an ENSO months in advance of its onset should, in principle, facilitate hazard evaluation, risk assessment and preparation for potential consequences by individuals, with an eye toward reducing disruption, damage and associated costs. This sequence of logical steps, we discovered, is not as readily or consistently followed as might be expected. While some of the hazards associated with ENSO, such as drought or floods, could permit careful and calculated responses as well as rationalization of resource management, other effects are much less predictable and pose much greater uncertainties. Indeed, natural hazards and the damage they cause may be greatly exacerbated by generalized or “background” social, economic, and political conditions. This insight suggests the need for a different approach to the problems under study in this project.

Looking more carefully at the literature, we found that, in recent years, some analysts of risk and risk perception research have taken a more sociological turn. Early research treated risk as objectively quantifiable and risk perception as exogenously-given. Dealing with risk and hazards was simply a matter of “knowing the facts,” a standpoint which treated contradictory responses to risk as a form of irrational pathology. During the 1990s, a new approach emerged that treated both risk assessment and perception as endogenously constructed, at least in part, and subject to a range of cultural, social, and structural effects.

Thus, when we began to examine the social context of our subject groups through specific cases, we found that people’s stories about risks and hazards—especially those they had experienced—were a good deal more complicated and contingent than expected. If we are to comprehend in general how vulnerable individuals and groups make decisions with respect to

risk and hazards, and act on them, we also need to find a way to move between the macro-world of economic rationality and the micro-world of ethnography.

Through our interviews, we also found that the concept of risk itself is a problematic one. The reasons for this have little to do with quantification or assumptions about individuals as rational actors. Risk, risk perception and response, as well as the individual propensity to take or avoid risks, are social products. Most research into risk assessment and most conclusions about risk perception fail to take these points into account. Hazards do not develop nor are they perceived as a result of purely objective circumstances; rather, they are a result of social context.

Perhaps the most serious shortcoming of standard risk approaches that we found is that individuals and communities understand and anticipate their exposure to hazards in terms of vulnerability, and not as a probabilistic likelihood of suffering costs or experiencing benefits from extreme events. Individuals' ideas about uncertainty, risk, and rationality are conditioned by awareness of both the contexts and contingencies of everyday life, and these have more to do with vulnerability than generalized risk. Individuals and groups in vulnerable communities tend to assess the threat of disaster primarily in terms of their own or others' prior experience, and to a much lesser extent in purely economic terms (this is less the case for growers, who are always very sensitive to finances and market conditions). These experiences become the metric by which other events are measured, and they establish the boundary conditions for the "worst that can happen" in the future. Obviously, some events will be so extreme that they fall outside of the boundaries of experience; at the same time, events that we might consider extreme are regarded by others as part of the occasional fabric of everyday life, that is, outside of the norm but something that happens.

3. How people respond

Our findings highlight a recent alternative approach to hazard exposure known as "vulnerability studies." Vulnerability is differentiated from risk in several ways. First, whereas risk is a statistical quantity calculated on the basis of numbers of incidents per thousand or million population—and is, in this respect, identical to epidemiology—vulnerability recognizes that, in any given population, identical incidents expose some to greater risks than others. Second, part of this difference may be ascribed to individual choice, but much of it can be attributed to social and structural factors. And, third, perceptions of risk by those with differing vulnerabilities is partly a function of prior experience and partly the availability of what are called "entitlements" and "coping resources and strategies."

We found that individual and group coping strategies vary, and so does the extent of their losses. For example, some residents have adapted to the environment by reducing the vulnerability of their homes when rebuilding after earlier floods. Others cannot afford to do this, and are unable to recover (especially when a succession of extreme events depletes their coping resources). Neighbors, family and friends provide materials and labor, but there are intangible costs that social networks cannot provide. A few move away. But experience is a valuable teacher, and the lessons learned are those that could never be supplied by outside sources.

Growers and fishers have somewhat different coping strategies. Growers are continually

exposed to a range of uncertainties, ranging from those associated with variable weather to water supply during the dry season to market conditions when crops are ready to ship. Some growers have greater access to capital, and can use it to spread out risk and reduce vulnerability. For example, growing in different parts of the state at different times of the year can eliminate much of their vulnerability to variability in the weather and water supply. For others, who farm under contract or have only relatively small acreage, bad weather at the wrong time or a technological mishap can ruin the entire crop. These more vulnerable growers draw upon their own knowledge and experience, and close observation of weather and other conditions within the microclimates in which they work, within and across seasons, to sustain their enterprises. They take the inherent variability in growing conditions and production success as a given, continually adapting their strategies and practices to enable them and their operations to survive over time.

Fishermen, by contrast, exercise much less control over the resources they pursue but have a high degree of mobility in most cases. ENSO has a clear effect on species such as squid that are especially sensitive to changes in water temperature, and may cause stocks to shift to other locations along the Pacific Coast, or disappear altogether. For those who have seaworthy vessels, a willing market, and the knowledge and other resources to support them, following the fish may be possible. In the larger California wetfish fishery that includes squid, alternative species such as sardine and anchovy are potential substitutes, although limited quotas (for sardine) and markets, and low prices diminish their viability as such. In other cases, a scarcity of forage fish may mean fewer, and likely smaller, fish for fishermen to target. For salmon fishermen, this circumstance may be complicated by increases in predation by marine mammals in search of substitutes for other less abundant species. Moreover, for all of these fishermen, specific weather conditions such as high winds and large swells may impede access to fishing grounds and preclude safe operation of their gear.

Information about fishing conditions is both a closely-held resource *and* a shared one. Most fishermen strike a careful balance between withholding and sharing information and other resources, valuing their own knowledge and experience, yet often recognizing the limits of those resources and the potential pay-offs from sharing key insights into the vast, uncertain, variable, and potentially dangerous environment in which they work.

Experience, we found, is not simply an individual resource; it is a community asset (i.e., a public good). Information and forecasts from outside sources cannot provide these kinds of lessons. In areas in which terrain is highly diverse and infrastructure is unevenly provided, as in the Santa Cruz Mountains or the Pajaro River Valley, our research showed that the impacts of certain hazards are highly variable, even across distances as small as a city block. Short-term forecasts are extrapolated to specific locations for which there might be written records but often only individual experience is available. Knowing that a particular storm might drop one to three inches of precipitation is less critical than keeping an eye on local markers that indicate severity and rainfall rates. Long-term forecasts (for example, of an ENSO) can provide a “heads-up” warning about probable events and conditions, and motivate certain kinds of preparations, but it is the individual storms that matter most in terms of vulnerability. This is especially the case when individuals and communities cannot afford to modify their situations (building levees or seawalls; raising or moving houses and buildings; farm in flood-prone areas) but can only react and recover.

If vulnerability is highly-localized, what kind of information and assistance is most useful to those who are most vulnerable to weather-related hazards? How can external agents help to facilitate the accumulation of appropriate local knowledge and social capital? Here, it is appropriate to examine how people behave in the face of uncertainty, especially over the course of a season. From a situational or social perspective, different groups of actors respond to hazards and events in different ways. Farmers are accustomed to thinking strategically with respect to variability in both natural and economic factors; homeowners tend, initially, to regard their situations as relatively static and their houses as fixed, and are usually surprised by sudden change. With experience, they become more aware of their vulnerabilities and, in some cases, are able to adapt to them. Fishers adapt to local shortages and, depending on individual socio-cultural, economic and regulatory opportunities and constraints. They may switch to a different fishery within their “annual round,” following the fish to an alternative location, as with squid at the Channel Islands, or “weather the storm” by finding temporary employment outside fishing.

4. Conclusions

This analysis and our fieldwork leads to the following conclusions:

1. There is a distinct contrast between risk and vulnerability, as calculated and acted upon: individuals and communities understand and anticipate their exposure to hazards in terms of vulnerability, and not as a probabilistic likelihood of suffering costs from extreme events. That is, they tend to assess the threat of disaster in terms of past experience of discrete events within their local physical, social and economic context. These events become the metric by which others are measured, and the boundary conditions for the “worst that can happen.” The specific exposure of individuals to hazards depends on both physical and social conditions which, together, constitute “vulnerability.”

2. There is a repertoire of responses to hazards, based substantially on “local knowledge” that is specific to particular communities. In the course of our work, we have identified, for example, two small flood plain neighborhoods in the Santa Cruz Mountains whose response to natural hazards and events has been quite distinct. One has a long-standing homeowners association, the other has only recently established a neighborhood group. Residents in the first have extensive experience with floods and cooperate closely when one is imminent. Residents of the second neighborhood have similar experience as individuals, but have not had the benefit of shared local knowledge about hazards and floods. We attribute this to shorter residence times and much weaker institutional organization. Among residents of the two Pajaro River Valley communities we interviewed, individuals’ responses are shaped by close relations with (nuclear and extended) family, and the resources these provide. Local NGOs also provide critical socially and culturally appropriate resources – and liaison with government officials and other external actors – for these residents.

3. There is an epistemological disjuncture between emergency service agencies and vulnerable communities: The Santa Cruz County Office of Emergency Services is one of the best-prepared and proactive agencies in the state. Moreover, the County seems to experience more in the way of events than many other counties. As a result, agency personnel are very

attentive to potential risks and hazards, and have detailed plans in place for dealing with them. At the same time, however, much of this knowledge and practice appears to have a limited impact on vulnerable communities, such as those where we have been conducting interviews. This disjuncture appears to arise because the agency has to deal with generalized “populations,” while individuals act on the basis of what they know and what they have experienced in localized context. As a result, there is a great deal of “talking past each other,” especially when they speak different languages (both metaphorically and literally).

4. Personal and social knowledge is often more important than formal information: “Local knowledge” is highly social and rooted in three sources. Not surprisingly, it draws heavily on individual experience. It also relies on individual experiences communicated through social networks and, especially, structured groups. Finally, it is based on the accumulated “traditions” and rules of social groups which, in this instance, have to do with an understanding of very specific local and even household vulnerability and sensitivity. Externally-provided information can be helpful in setting boundary conditions for hazards and events, but it cannot provide the guidance needed by individuals acting in contingent and contextual situations.

D. Publications & presentations

Pomeroy, C. and R.D. Lipschutz. “Risk, Resilience and Rising Waters: How Monterey Bay River Valley Residents Adapt to Unfriendly Terrains, in: L. Fox, M. FitzSimmons, and R.D. Lipschutz (eds.), *California’s Edge: Society and Nature, Ecologies and Environments along the Central Coast* (in preparation).

The following were informed, at least in part, by research associated with this project:

Mangel, M., B. Marinovic, C. Pomeroy and D. Croll. “Requiem for Ricker: Unpacking MSY. Proceedings of Mote Marine Symposium,” *Bulletin of Marine Science*, in press.

Pomeroy, C. 2002. “Socio-economic impacts of pinniped-fishery interactions on California commercial salmon trollers.” NMFS Project Report.

Pomeroy, C., and M. FitzSimmons. 2001. “Socio-economic organization of the California market squid fishery: Assessment for optimal resource management.” California Sea Grant Project Report.

Pomeroy, C. 2001. “The changing culturescape of Monterey Bay: Fishermen, managers and institutional reform.” Society for Applied Anthropology, Merida, Mexico.

Pomeroy, C. 2000. “Harvested resources: Squid.” *Ecosystem Observations*. Monterey: Monterey Bay National Marine Sanctuary.

E. Deviations from workplan

We deviated from our initial research plan at three points.

1. **Hazard scale:** We intended to collect MBR weather and oceanographic data on ENSO-related parameters and develop a “hazard scale” to pinpoint research sites around the MBR. On a gross scale, this was useful. As we proceeded with other aspects of our archival and field research, however, the efficacy of this hazard scale for *pinpointing* research sites proved to be quite limited. This was largely because the information was not sufficiently site and time-specific, and it did not afford a clear sense of particular vulnerabilities within the groups of interest. We turned, therefore, to reviews of news media and exploratory interviews in which informants from agencies, NGOs and the groups involved helped us identify more and less vulnerable groups, and appropriate informants.

2. **Structured interviews:** We had planned to conduct highly structured survey interviews, but adopted a more ethnographic approach following pilot stage interviews. Whereas survey interviews would have enabled quantification of our results and possible analytical generalization (Yin, Robert K. 1989. *Case study research: Design and methods*. Newbury Park, CA: Sage), we became acutely aware that such an approach was ill-suited to the project's goals. An ethnographic approach would allow us to gain a more valid and useful set of data with which to work.

3. **Fishing community interviews:** We adapted our approach to account for and take advantage of Pomeroy's ongoing studies with MBR commercial squid and salmon fishers. A primary focus of those studies was how individuals and groups of fishers perceive, are affected by and adapt to environmental, economic and regulatory uncertainty and variability. The timing of these studies, prior to and through the 1997-98 ENSO, afforded a unique opportunity to examine perceptions and responses in “real time.” We therefore analyzed the data in hand, and collected new data as needed, to address the present study's themes.

IV. Relevance to the field of human-environment interactions

A. Implications of research for use of climate information in decision-making

The conventional understanding of the relationship between individual risk from exposure to environmental hazards such as ENSOs and climate variability, and the provision of information intended to reduce uncertainty and risk, is that rational “consumers” will utilize such data to calculate the costs and benefits of exposure reduction and choose accordingly. In terms of the context of this project, and its funding source (NOAA), the public provision of climate and weather information can be understood as an element of a global political economy of applied science. This kind of information is thought to be of considerable value, inasmuch as it can provide considerable lead time for preparation for possible hazards and disasters.

In this project, we have sought to test the assumption of individual rationality, focusing on selected social and economic groups living and working within a spatially-restricted region, seeking data through in-depth, partially-structured ethnographic interviews. Our research

suggests that the highly-idealized rational consumer model suffers from several methodological and epistemological flaws that should be heeded in research, policymaking, and planning. Specifically, so long as the kind of information forthcoming from major research projects is not available in a form, or covering a time frame, that can substantially help people to reduce both vulnerability and risk, such information will be of limited practical utility. Vulnerability arises from a range of factors—social, economic, demographic and political—and interacts with discrete weather events to produce “disasters.” Interseasonal forecasting is too imprecise to allow people to reduce substantially this type of exposure to risk.

As several interviewees pointed out, externally-generated information would be most useful if it were tailored to or at least more responsive to the context in which it is used, and the vulnerabilities of those who (could) use it. At the same time, they note that there are contingencies that simply cannot be addressed with external information alone, and that information cannot eliminate people’s vulnerabilities. Because of this, people integrate experience and knowledge with weather and other sources of information to adapt to particular situations. Recognition of these realities in the production of climate and weather information could lead to more effective use of that information.

B. Relationship to previously-funded HDGEC research

None

C. Contribution to the following areas of study

1. Adaptation to long-term climate change: We found no specific adaptive strategies to long-term climate change among the three groups we studied. In general, some individuals in the three groups had developed strategies for responding to short-term weather variability and unexpected extreme events, so long as these were within certain bounds. None of these responded to the possibility of long-term change. Should extreme events become more common, we might expect to see a shift in strategies but, until forecasts are more certain about the magnitude and location of long-term events, it is unlikely that individuals will pay the costs of adaptation without evidence of clear benefits.

2. Natural hazards mitigation: Residents with well-developed social networks were more able to address natural hazards and to mitigate associated damages. For example, in one of the riverside residential communities studied, long-time residents had prior experience with flooding and were able to advise newer residents of the danger of flooding and the need to evacuate to higher ground. In a second community, however, such experience was not available, and language barriers also inhibited communication. While government agencies are respected by some as sources of warnings and advice, they are regarded with suspicion by other long-term and recent arrivals to the region. Moreover, agencies are external to the local social networks and tend to act in a general fashion that does not address local, contextualized settings. Among growers, there was less evidence of reliance on social networks among colleagues, but more in the way of self-reliance, and recently, cooperative work with federal and state extension agents to address problems such as erosion. Fishers also worked more independently to address and mitigate hazards and damages, and in fact, found that formal institutions (e.g., loan programs)

were ill-suited to help them adapt to natural hazards or the problems they faced as a result (e.g., the disappearance of the fish from fishing grounds).

3. Institutional dimensions of global change: We found that weather-sensitive communities (residents, farmers, fishers) are very interested in knowing more about the magnitude of climatic variability and, in particular, about the frequency and intensity of extreme events. Long-term trends can be anticipated and addressed, but impacts of and responses to extreme events are already a problem. Vulnerability is not often addressed systematically before the fact because (1) the disaster response system is not designed to anticipate hazards but, rather, to treat consequences; and (2) vulnerability is generally a consequence of socio-economic factors rather than purely physical ones.

4. Economic value of climate forecasts: This value is difficult to gauge. Our interviews suggested that weather-sensitive communities are able to make general preparations for unusual seasonal conditions (e.g., an ENSO) but are more interested in fore-warnings about specific extreme events, inasmuch as these are the sources of most disaster-related costs. Squid fishers are an exception, because of the dramatic and extended (12-24 months) effect ocean warming has on the availability and distribution of the resource.

5. Developing tools for decision makers and end-users: Responsible agencies and networks in the Monterey Bay region possess sophisticated communications systems and have designed elaborate assessment and response networks for dealing with local disasters (of which there seem to be more than average). While these agencies prepare for seasonal conditions (floods in winter; fires in summer), they respond to discrete events. For those purposes, they rely on certain indicators—for example, stream flow indicators in certain places—to assess the likelihood of an impending problem. End users rely on a variety of “tools,” including agency warnings, media, and social networks. Experience with earlier events and information sources is often important in assessment and response.

6. Sustainability of vulnerable areas and/or people: Vulnerability is often a function of socioeconomic status and social and economic “assets.” Those who have access to financial and social capital may find themselves exposed to hazards, but they are also able to choose whether or not to continue that exposure (they can rebuild or relocate). Those without access to capital and social assets may have to suffer through repeated exposure to events, without ever fully recovering or being in a position to rebuild or relocate. The institutional system is not designed or intended to address this type of vulnerability (it does better with purely physical exposures) and, so, poor communities exposed to natural hazards tend to suffer repeatedly from disasters. Public investment in reducing some aspects of this vulnerability could do much to address the problem.

7. Matching new scientific information with local/indigenous knowledge: Local knowledge, in this instance, represents the accumulation of experience and insight with respect to the relationships between weather variability, extreme events, and local conditions. The farmers we interviewed, for instance, were very aware of the particular microclimates in which they worked, and the differing sensitivities of their lands and crops to changing weather conditions. Due to seasonal conditions, there is no purely rain-fed agriculture in the MBR; primary concerns

therefore involve flooding, erosion and water-logging (due to late winter rains or flooding), and unexpected or unseasonal extreme temperatures. Fishers also possess cumulative knowledge of the species they target, and the relationship between weather and climate patterns and the availability and distribution of those target species. These sets of knowledge, in fact, could be used to develop hypotheses to be tested by standard scientific research or, perhaps more fruitfully, collaborative research involving scientists and growers/fishers. (Within the MBR and elsewhere, there is growing interest in and effort to establish such research linkages.)

8. The role of public policy in the use of climate information: Inasmuch as the costs of natural disaster-related damage have been growing over the past decade, it would appear that policy responses have not been adequate to the prevention or mitigation of such damages. There are, of course, limits to what governments can do in the case of many disasters, but a greater focus on highly-vulnerable communities and individual vulnerabilities within other communities would seem an appropriate direction for public policy research and action.

9. Socioeconomic impacts of decadal climate variability: We found that the costs of several extreme events were considerable in local terms, but rather small in terms of state and nation due to their limited spatial scope. If extreme events become more frequent as a result of decadal climate variability, the costs of disasters will eventually exceed people's ability to cope and society's ability and willingness to pay. In the Monterey Bay area, current areas of high vulnerability are limited in scope, and these costs have not yet become excessively high. Agriculture is a major economic sector in the region, and provides employment to large numbers of farmworkers. Farmers, however, must balance a variety of risk factors and seem willing to bear business losses for extended periods of time. Farmworkers are very vulnerable, but they are paid low wages and there is little data available to assess the impacts of climate variability on them

10. Other (e.g., gender issues, ways of communicating uncertain information): see above

D. Suggestions for future research

1. More fieldwork and case studies in other climate-sensitive areas
2. Better understanding of vulnerability and coping mechanisms
3. Examination of methods to address and reduce vulnerability
4. More attention to local knowledge and social networks
5. Climate-related information that is more accessible and specific
6. Greater interaction between responsible agencies and local communities
7. More accurate assessment of relative importance of various risk factors
8. Evaluation of the utility of interseasonal climate information